hydrochloric acid of 20° Bé. previously diluted with four times the quantity of water is mixed in, for every part of chloride of lime, the whole is stirred thoroughly, and the starch allowed to stand.

When the starch has settled, the supernatant water is let off and the starch is washed with fresh water until all odor of chlorine has entirely disappeared. The starch now obtained is the resulting final product.

If the starch thus treated is to be worked up into dextrin, it is treated in the usual manner with hydrochloric acid or nitric acid and will then furnish a dextrin perfectly free from taste and smell.

In case the starch is to be turned into "soluble" starch proceed as usual, in a similar manner as in the production of dextrin, with the single difference that the starch treated with hydrochloric or nitric acid remains exposed to a temperature of 212° F., only until a test with tincture of iodine gives a bluish-violet reaction. The soluble starch thus produced, which is clearly soluble in boiling water, is odorless and tasteless.

Starch Powder.—Finely powdered starch is a very desirable absorbent, according to Snively, who says that for toilet preparations it is usually scented by a little otto or sachet powder. Frangipanin powder, used in the proportion of 1 part to 30 of the starch, he adds, gives a satisfactory odor.

STARCHES:
See Laundry Preparations.

STARCH IN JELLY, TESTS FOR:
See Foods.

STARCH PASTE:
See Adhesives.

STATUE CLEANING:
See Cleaning Preparations and Methods.

STATUETTES, CLEANING OF:
See Plaster.

STATUETTES OF LIPOWITZ METAL:
See Alloys.

Steel

(See also Iron and Metals.)

ANNEALING STEEL:
See also Hardening Steel and Tempering Steel.

This work requires the use of substances which yield their carbon readily and quickly to the tools on contact at a high temperature. Experience has shown that the best results are obtained by the use of yellow blood-lye salt (yellow prussiate of potash), which, when brought in contact with the tool at a cherry-red heat, becomes fluid, and in this condition has a strong cementing effect. The annealing process is as follows: The tool is heated to a cherry red and the blood-lye salt sprinkled over the surface which is to be annealed. A fine sieve should be used, to secure an even distribution of the substance. The tool is then put back into the fire, heated to the proper temperature for tempering, and tempered. If it is desired to give a higher or more thorough tempering to iron or soft steel, the annealing process is repeated 2 or 3 times. The surface of the tool must, of course, be entirely free from scale. Small tools to which it is desired to impart a considerable degree of hardness by annealing with blood-lye salt are tempered as follows: Blood-lye salt is melted in an iron vessel over a moderate fire, and the tool, heated to a brown-red heat, placed in the melted salt, where it is allowed to remain for about 15 minutes. It is then heated to the hardening temperature and hardened. A similar but milder effect is produced in small, thin tools by making them repeatedly red hot, immersing them slowly in oil or grease, reheating them, and finally tempering them in water. To increase the effect, soot or powdered charcoal is added to the oil or grease (train oil) till a thick paste is formed, into which the red-hot tool is plunged. By this means the tool is covered with a thick, not very combustible, coating, which produces a powerful cementation at the next heating. By mixing flour, yellow blood-lye salt, saltpeter, horn shavings, or ground hoofs, grease, and wax, a paste is formed which serves the same purpose. A choice may be made of any of the preparations sold as a "hardening paste"; they are all more or less of the same composition. This is a sample: Melt 500 grains of wax, 500 grains tallow, 100 grains rosin, add a mixture of leather-coal, horn shavings, and ground hoofs in equal parts till a paste is formed, then add 10 grains saltpeter and 50 to 100 grains powdered yellow blood-lye salt, and stir well. The tools are put into this paste while red hot, allowed to cool in it, then reheated and tempered.

More steel is injured, and sometimes spoiled, by over-annealing than in any other way. Steel heated too hot in annealing will shrink badly when being hardened; besides, it takes the life out of it. It should never be heated above a

low cherry red, and it should be a lower heat than it is when being hardened. It should be heated slowly and given a uniform heat all over and through the piece.

This is difficult to do in long bars and in an ordinary furnace. The best way to heat a piece of steel, either for annealing or hardening, is in red-hot, pure lead. By this method it is done uniformly, and one can see the color all the time. Some heating for annealing is done in this way: Simply cover up the piece in sawdust, and let it cool there, and good results will be obtained.

Good screw threads cannot be cut in steel that is too soft. Soft annealing produces a much greater shrinkage and spoils the lead of the thread.

This mixture protects the appearance of polished or matted steel objects on heating to redness: Mix 1 part of white soap, 6 parts of chemically pure boracic acid, and 4 parts of phosphate of soda, after pulverizing, and make with water into a paste. For use, apply this to the article before the annealing.

COLORING STEEL:

Black.—I.—Oil or wax may be employed on hard steel tools; with both methods the tool loses more or less of its hardness and the blacking process therefore is suited only for tools which are used for working wood or at least need not be very hard, at any rate not for tools which are employed for working steel or cast iron. The handsomest glossy black color is obtained by first polishing the tool neatly again after it has been hardened in water, next causing it to assume on a grate or a hot plate the necessary tempering color, yellow, violet blue, etc., then dipping it in molten, not too hot, yellow wax and burning off the adhering wax, after withdrawal, at a fire, without, however, further heating the tool. Finally dip the tool again into the wax and repeat the burning off at the flame until the shade is a nice lustrous black, whereupon the tool may be cooled off in water. The wax is supposed to impart greater toughness to the tool. It is advisable for all tools to have a trough of fat ready, which has been heated to the necessary tempering degree, and the tools after hardening in water are suspended in the fat until they have acquired the temperature of the fat bath. When the parts are taken out and slowly allowed to cool, they will be a nice, but not lustrous, black.

II.—The following has been suggested for either steel or iron:

Bismuth chloride...	1 part
Mercury bichloride.	2 parts
Copper chloride....	1 part
Hydrochloric acid..	6 parts
Alcohol..........	5 parts
Water sufficient to make 64 parts.	

Mix. As in all such processes a great deal depends upon having the article to be treated absolutely clean and free from grease. Unless this is the case uniform results are impossible. The liquid may be applied with a swab, or a brush, but if the object is small enough to dip into the liquid better results may thus be obtained than in any other way. The covering thus put on is said to be very lasting, and a sure protection against oxidation.

Blue.—I.—Heat an iron bar to redness and lay it on a receptacle filled with water. On this bar place the objects to be blued, with the polished side up. As soon as the article has acquired the desired color cause it to fall quickly into the water. The pieces to be blued must always previously be polished with pumice stone or fine emery.

II.—For screws: Take an old watch barrel and drill as many holes into the head of it as the number of screws to be blued. Fill it about one-fourth full of brass or iron filings, put in the head, and then fit a wire long enough to bend over for a handle, into the arbor holes—head of the barrel upward. Brighten the heads of the screws, set them, point downward, into the holes already drilled, and expose the bottom of the barrel to the lamp until the screws assume the color you wish.

III.—To blue gun-barrels, etc., dissolve 2 parts of crystallized chloride of iron; 2 parts solid chloride of antimony; 1 part gallic acid in 4 or 5 parts of water; apply with a small sponge, and let dry in the air. Repeat this two or three times, then wash with water, and dry. Rub with boiled linseed oil to deepen the shade. Repeat this until satisfied with the result.

IV.—The bluing of gun barrels is effected by heating evenly in a muffle until the desired blue color is raised, the barrel being first made clean and bright with emery cloth, leaving no marks of grease or dirt upon the metal when the bluing takes place, and then allow to cool in the air. It requires considerable experience to obtain an even clear blue.

Brown.—I.—The following recipe for browning is from the United States Ordnance Manual: Spirits of wine, 1½

ounces; tincture of iron, 1½ ounces; corrosive sublimate, 1½ ounces; sweet spirits of niter, 1½ ounces; blue vitriol, 1 ounce; nitric acid, ¾ ounce. Mix and dissolve in 1 quart of warm water and keep in a glass jar. Clean the barrel well with caustic soda water to remove grease or oil. Then clean the surface of all stains and marks with emery paper or cloth, so as to produce an even, bright surface for the acid to act upon, and one without finger marks. Stop the bore and vent with wooden plugs. Then apply the mixture to every part with a sponge or rag, and expose to the air for 24 hours, when the loose rust should be rubbed off with a steel scratch brush. Use the mixture and the scratch brush twice, and more if necessary, and finally wash in boiling water, dry quickly, and wipe with linseed oil or varnish with shellac.

II.—Apply four coats of the following solution, allowing each several hours to dry. Brush after each coat if necessary. After the last coat is dry, rub down hard.

Sulphate of copper...	1 ounce
Sweet spirits of niter..	1 ounce
Distilled water.......	1 pint

Niello.—This is a brightly polished metal, which is provided with a black or blue-black foundation by heating, is covered with a design by the use of a suitable matrix and then treated with hydrochloric acid in such a manner that only the black ground is attacked, the metal underneath remaining untouched. Next, the acid is rinsed off and the reserve is removed with suitable solvents. The parts of the metal bared by the acid may also be provided with a galvanic coating of silver or other metal.

Another method is to plunge the articles for a few minutes into a solution of oxalic acid and to clean them by passing them through alcohol. In this way the polish can even be brought back without the use of rouge or diamantine.

Whitening or Blanching.—If dissatisfied with the color acquired in tempering, dip the article into an acid bath, which whitens it, after which the bluing operation is repeated. This method is of great service, but it is important to remember always thoroughly to wash after the use of acid and then allow the object to remain for a few minutes in alcohol. Sulphuric acid does not whiten well, often leaving dark shades on the surface. Hydrochloric acid gives better results. Small pieces of steel are also whitened with a piece of pith moistened with dilute sulphuric acid, else the fine steel work, such as a watch hand, is fixed with lacquer on a plate and whitened by means of pith and polishing rouge, or a small stiff brush is charged with the same material. It is then detached by heating and cleaned in hot alcohol.

TEMPERING STEEL.

The best temperature at which to quench in the tempering of tool steel is the one just above the transformation point of the steel, and this temperature may be accurately determined in the following manner, without the use of a pyrometer. The pieces of steel are introduced successively at equal intervals of time into a muffle heated to a temperature a little above the transformation point of the steel. If, after a certain time, the pieces be taken out in the reverse order they will at first show progressively increasing degrees of brightness, these pieces being at the transformation point. When this point is passed the pieces again rapidly acquire a brightness superior to that of their neighbors, and should then be immediately quenched.

I.—Heat red hot and dip in an unguent made of mercury and the fat of bacon. This produces a remarkable degree of hardness and the steel preserves its tenacity and an elasticity which cannot be obtained by other means.

II.—Heat to the red white and thrust quickly into a stick of sealing wax. Leave it a second, and then change it to another place, and so continue until the metal is too cool to penetrate the wax. To pierce with drills hardened in this way, moisten them with essence of turpentine.

To Temper Small Coil Springs and Tools.—To temper small coil springs in a furnace burning wood the springs are exposed to the heat of the flame and are quenched in a composition of the following preparation: To a barrel of fish oil, 10 quarts of rosin and 12 quarts of tallow are added. If the springs tempered in this mixture break, more tallow is added, but if the break indicates brittleness of the steel rather than excessive hardness, a ball of yellow beeswax about 6 inches in diameter is added. The springs are drawn to a reddish purple by being placed on a frame having horizontally radiating arms like a star which is mounted on the end of a vertical rod. The springs are laid on the star and are lowered into a pot of melted lead, being held there for such time as is required to draw to the desired color.

It is well known that the addition of

certain soluble substances powerfully affects the action of tempering water. This action is strengthened if the heat-conducting power of the water is raised by means of these substances; it is retarded if this power is reduced, or the boiling point substantially lowered. The substance most frequently used for the purpose of increasing the heat-conducting power of tempering water is common salt. This is dissolved in varying proportions of weight, a saturated solution being generally used as a quenching mixture. The use of this solution is always advisable when tools of complicated shape, for which a considerable degree of hardness is necessary, are to be tempered in large quantities or in frequent succession. In using these cooling fluids, care must be taken that a sufficient quantity is added to the water to prevent any great rise of temperature when the tempering process is protracted. For this reason the largest possible vessels should be used, wide and shallow, rather than narrow and deep, vessels being selected. Carbonate of soda and sal ammoniac do not increase the tempering action to the same extent as common salt, and are therefore not so frequently employed, though they form excellent additions to tempering water in certain cases. Tools of very complicated construction, such as fraises, where the danger of fracture of superficial parts has always to be kept in view, can with advantage be tempered in a solution of soda or sal ammoniac. Acids increase the action of tempering water considerably, and to a far greater extent than common salt. They are added in quantities up to 2 per cent, and frequently in combination with salts. Organic acids (e. g., acetic or citric) have a milder action than mineral acids (e. g., hydrochloric, nitric, or sulphuric). Acidulous water is employed in tempering tools for which the utmost degree of hardness is necessary, such as instruments for cutting exceptionally hard objects, or when a sufficiently hard surface has to be given to a kind of steel not capable of much hardening. Alcohol lowers the boiling point of water, and causes so vigorous an evaporation when the water comes in contact with the red-hot metal, that the tempering is greatly retarded (in proportion to the amount of alcohol in the mixture). Water containing a large quantity of alcohol will not temper. Soap and soap suds will not temper steel; this property is made use of in the rapid cooling of steel for which a great degree of hardness is not desirable. When certain parts of completely tempered steel have to be rendered soft, these parts are heated to a red heat and then cooled in soap suds. This is done with the tangs of files, knives, swords, saws, etc. Soluble organic substances retard the tempering process in proportion to the quantity used, and thus lessen the effect of pure water. Such substances (e. g., milk, sour beer, etc.) are employed only to a limited extent.

To Caseharden Locally.—In casehardening certain articles it is sometimes necessary, or desirable, to leave spots or sections in the original soft uncarbonized condition while the remainder is carbonized and hardened. This may be effected by first covering the parts to be hardened with a protecting coat of japan, and allowing it to dry. Then put the piece in an electroplating bath and deposit a heavy coat of nickel over the parts not protected by the japan. The piece thus prepared may be treated in the usual manner in casehardening. The coat of nickel prevents the metal beneath being carbonized, so it does not harden when dipped in the bath.

A plating of copper answers the same purpose as nickel and is often used. A simpler plan, where the shape of the piece permits, is to protect it from the action of the carbonizing material with an iron pipe or plate closely fitted or luted with clay. Another scheme is to machine the parts wanted soft after carbonizing but before hardening. By this procedure the carbonized material is removed where the metal is desired soft, and when heated and dipped these parts do not harden.

To Harden a Hammer.—To avoid the danger of "checking" a hammer at the eye, heat the hammer to a good uniform hardening heat and then dip the small end almost up to the eye and cool as quickly as possible by moving about in the hardening bath; then dip the large end. To harden a hammer successfully by this method one must work quickly and cool the end dipped first enough to harden before the heat is lost on the other end. Draw the temper from the heat left about the eye. The result is a hammer hard only where it should be and free from "checks."

Hardening Steel Wire.—Pass the steel wire through a lead bath heated to a temperature of 1,200° to 1,500° F. after it has previously been coated with a paste of chalk, so as to prevent the formation

of oxides. The wire is thus heated in a uniform manner and, according to whether it is desired hard or elastic, it is cooled in water or in oil.

Hardening of Springs.—A variety of steel must be chosen which is suitable for the production of springs, a very tough quality with about 0.8 per cent of carbon being probably the best. Any steel works of good reputation would no doubt recommend a certain kind of steel. In shaping a spring, forging and hammering should be avoided if possible. In forging, an uneven treatment can scarcely be avoided; one portion is worked more than the other, causing tensions which, especially in springs, must be guarded against. It is most advantageous if a material of the thickness and shape of the spring can be obtained, which, by bending and pressing through, is shaped into the desired spring. Since this also entails slight tension, a careful annealing is advisable, so as to prevent cracking or distorting in hardening. The annealing is best conducted with exclusion of the air, by placing the springs in a sheet-iron box provided with a cover, smearing all the joints well up with loam. The heating may be done in a muffled furnace; the box, with contents, is, not too slowly, heated to cherry red and then allowed to cool gradually, together with the stove. The springs must only be taken out when they have cooled off enough that they will give off no hissing sound when touched by water. In order to uniformly heat the springs for hardening, a muffle furnace is likewise employed, wherein they are heated to cherry-red heat. For cooling liquid, a mixture of oil, tallow, and petroleum is employed. A mass consisting of fish oil, tallow, and wax also renders good service, but one should see to it that there is a sufficient quantity of these cooling liquids, so that the springs may be moved about, same as when cooled in water, without causing an appreciable increase in the temperature of the liquid. In most cases too small a quantity of the liquid is responsible for the many failures in hardening. When the springs have cooled in the hardening liquid, they are taken out, dried off superficially, and the oil still adhering is burned off over a charcoal fire. This enables one to moderate the temper according to the duration of the burning off and to produce the desired elasticity. An even heating being of great importance in hardening springs, the electric current has of late been successfully employed for this purpose.

To Temper a Tap.—After the tap has been cut and finished heat it in a pair of tongs to a blood-red heat over a charcoal fire or the blue flame of a Bunsen burner or blow pipe, turning it around so that one point does not get heated before another. Have ready a pail of clean, cold water, into which a handful of common salt has been put. Stir the water in the pail so that a whirlpool is set up. Then plunge the tap, point first and vertically, into the vortex to cool. The turning of the tap during heating, as well as the swirl of the quenching water, prevents distortion. In tempering, the temper of the tap requires to be drawn to a light straw color, and this may be done as follows: Get a piece of cast-iron tube about 3 inches in diameter and heat it to a dull-red heat for about 4 inches of its length. Then hold the tap, with the tongs, up the center of the tube, meanwhile turning the tap around until the straw color appears all over it. Then dip the tap in the water, when it will be found perfectly hard. The depth of the color, whether light or dark straw, must be determined by the nature of the cast steel being used, which can be gained only from experience of the steel.

Scissors Hardening.—The united legs of the scissors are uniformly heated to a dark cherry red, extending from the point to the screw or rivet hole. This may be done in the naked fire, a feeble current of air being admitted until the steel commences to glow. Then the fire is left to itself and the scissor parts are drawn to and fro in the fire, until all the parts to be hardened show a uniform dark cherry red. The two legs are hardened together in water and then tempered purple red to violet.

The simultaneous heating, hardening, and tempering of the parts belonging together is necessary, so that the degree of heat is the same and the harder part does not cut the softer one.

In accordance with well-known rules, the immersion in the hardening bath should be done with the point first, slowly and vertically up to above the riveting hole.

Hardening without Scaling.—Articles made of tool steel and polished may be hardened without raising a scale, thereby destroying the polish, by the following method: Prepare equal parts in bulk of common salt and (fine) corn meal, well mixed. Dip the article to be hardened first into water, then into the mixture and place it carefully into the fire. When hot enough to melt the mixture, take from

the fire and dip or roll in the salt and meal, replace in the fire and bring to the required heat for hardening. Watch the piece closely and if any part of it shows signs of getting dry, sprinkle some of the mixture on it. The mixture, when exposed to heat, forms a flux over the surface of the steel which excludes the air and prevents oxidation, and when cooled in water or oil comes off easily, leaving the surface as smooth as before heating. Borax would possibly give the same result, but is sometimes difficult to remove when cold.

Hardening with Glycerine.—I.—The glycerine employed must be of the density of 1.08 to 1.26 taken at the temperature of 302° F. Its weight must be equal to about 6 times the weight of the pieces to be tempered. For hard temper add to the glycerine ¼ to 4 per cent of sulphate of potash or of manganese, and for soft temper 1 to 10 per cent of chloride of manganese, or 1 to 4 per cent of chloride of potassium. The temperature of the tempering bath is varied according to the results desired.

II.—Glycerine, 8,000 parts, by weight; cooking salt, 500 parts, by weight; sal ammoniac, 100 parts, by weight; concentrated hydrochloric acid, 50 parts; and water, 10,000 parts, by weight. Into this liquid the steel, heated, for example, to a cherry red, is dipped. A reheating of the steel is not necessary.

To Remove Burnt Oil from Hardened Steel.—To remove excess oil from parts that have been hardened in oil, place the articles in a small tank of gasoline, which, when exposed to the air, will dry off immediately, allowing the part to be polished and tempered without the confusing and unsightly marks of burnt oil.

VARIOUS RECIPES:

To Put an Edge on Steel Tools.—Aluminum will put an edge on fine cutting instruments such as surgical knives, razors, etc. It acts exactly like a razor-hone of the finest quality. When steel is rubbed on the aluminum, as, for instance, in honing a knife blade, the metal disintegrates, forming an infinitely minute powder of a greasy unctuous quality that clings to steel with great tenacity and thus assists in cutting away the surface of the harder metal. So fine is the edge produced that it can in no wise be made finer by the strop, which used in the ordinary way merely tends to round the edge.

To Restore Burnt Steel.—To restore burnt cast steel heat the piece to a red heat and sprinkle over it a mixture of 8 parts red chromate of potassium; 4 parts saltpeter; ⅓ part aloes; ⅓ part gum arabic; and ¼ part rosin.

To Remove Strains in Metal by Heating.—In making springs of piano wire or, in fact, any wire, if the metal is heated to a moderate degree the spring will be improved. Piano or any steel wire should be heated to a blue, brass wire to a degree sufficient to cause tallow to smoke. Heating makes the metal homogeneous; before heating, it is full of strains.

If a piece of metal of any kind is straightened cold and then put into a lathe and a chip turned off, it will be far from true. Before turning, it was held true by the strain of the particles on the outside, they having changed position, while the particles near the axis are only sprung. The outside particles being removed by the lathe tool, the sprung particles at the center return to their old positions. If after straightening, the metal is heated to a temperature of 400° F., the particles settle together and the strains are removed.

This is the case in the manufacture of saws. The saw is first hardened and tempered and then straightened on an anvil by means of a hammer. After it is hammered true, it is ground and polished a little, then blued to stiffen it and then is subjected to the grinding process. Before bluing, the metal is full of strains; these are entirely removed by the heat required to produce the blue color. Often a piano-wire spring will not stand long wear if used without heating, while if heated it will last for years.

To Render Fine Cracks in Tools Visible.—It is often of importance to recognize small cracks which appear in the metal of the tools. For this purpose it is recommended to moisten the fissured surface with petroleum; next rub and dry with a rag and rub again, but this time with chalk. The petroleum which has entered the cracks soon comes out again and the trace is plainly shown by the chalk.

To Utilize Drill Chips.—There is one modern machining process that produces a shaving that has more value than that of mere scrap, and that is drilling rifle barrels with the oil-tube drill. The cutting edge of this drill is broken up into steps and the chips produced are literally shavings, being long hair-like threads of steel. These shavings are considerably used in woodworking factories for smoothing purposes.

To Remove Fragments of Steel from Other Metals.—The removal of broken spiral drills and taps is an operation which even the most skillful machinist has to perform at times. A practical process for removing such broken steel pieces consists in preparing in a suitable kettle (not iron) a solution of 1 part, by weight, of commercial alum in 4 to 5 parts, by weight, of water and boiling the object in this solution until the piece which is stuck works itself out. Care must be taken to place the piece in such a position that the evolving gas bubbles may rise and not adhere to the steel to protect it from the action of the alum solution.

Testing Steel.—A bar of the steel to be tested is provided with about nine notches running around it in distances of about $\frac{3}{8}$ of an inch. Next, the foremost notched piece is heated in a forge in such a manner that the remaining portion of the bar is heated less by the fire proper than by the transmitted heat. When the foremost piece is heated to burning, i. e., to combustion, and the color of the succeeding pieces gradually passes to dark-brownish redness, the whole rod is hardened. A test with the file will now show that the foremost burned piece possesses the greatest hardness, that several softer pieces will follow, and that again a piece ordinarily situated in the second third, whose temperature was the right one for hardening, is almost as hard as the first one. If the different pieces are knocked off, the fracture of the piece hardened at the correct temperature exhibits the finest grain. This will give one an idea of the temperature to be employed for hardening the steel in question and its behavior in general. Very hard steel will readily crack in this process.

Welding Compound.—Boracic acid, 41½ parts; common salt 35 parts; ferrocyanide of potassium, 20 parts; rosin, 7½ parts; carbonate of sodium, 4 parts. Heat the pieces to be welded to a light-red heat and apply the compound; then heat to a strong yellow heat and the welding may be accomplished in the usual manner.

The precaution should be observed, the same as with any of the cyanides, to avoid breathing the poisonous fumes.

Softening Steel.—Heat the steel to a brown red and plunge into soft water, river water being the best. Care should be taken, however, not to heat over brown red, otherwise it will be hard when immersed. The steel will be soft enough to be cut with ease if it is plunged in the water as soon as it turns red.

Draw-Tempering Cast Steel.—First heat the steel lightly by means of charcoal until of a cherry-red shade, whereupon it is withdrawn to be put quickly into ashes or dry charcoal dust until completely cooled. The steel may also be heated in the forge to a red cherry color, then hammered until it turns blue and then plunged into water.

Drilling Hard Steel.—To accomplish the object quickly, a drill of cast steel should be made, the point gradually heated to the red, the scales taken off, and the extremity of the point immersed at once in quicksilver; then the whole quenched in cold water. Thus prepared, the drill is equal to any emergency; it will bore through the hardest pieces. The quantity of quicksilver needed is trifling.

Engraving or Etching on Steel.—Dissolve in 150 parts of vinegar, sulphate of copper, 30 parts; alum, 8 parts; kitchen salt, 11 parts. Add a few drops of nitric acid. According to whether this liquid is allowed to act a longer or shorter time, the steel may be engraved upon deeply or the surface may be given a very ornamental, frosted appearance.

To Distinguish Steel from Iron.—Take a very clean file and file over the flame of an alcohol lamp. If the filed piece is made of steel, little burning and crackling sparks will be seen. If it consists of iron, the sparks will not crackle.

STAINLESS STEEL:

In the United States we have a stainless alloy termed "stellite," one consisting of 75% cobalt and 25% chromium, invented by Elwood Haynes of Kokomo, Indiana.† It is used for lathe tools, surgical knives, and cutlery; and is stainless. Many tests made at Purdue University showed little or no effect when treated with 20% nitric acid, 25% sulphuric acid, 23% hydrochloric acid, 38% hydrofluoric acid, 10% acetic acid, aqua regia, 5% carbolic acid, 90% phosphoric acid, 10% caustic soda, 5% mercuric chloride, iodine tincture, formaldehyde, 5% potassium permanganate, 10% silver nitrate, 10% copper sulphate, 5% oxalic acid, and sodium hypochlorite.

STEEL, TO CLEAN:

See Cleaning Preparations and Methods.

STENCILS FOR PLOTTING LETTERS OF SIGN PLATES:
See Enameling.

STENCIL INKS:
See Inks.

STEREOCHROMY.

Stereochromatic colors can be bought ground in a thickly liquid water-glass solution. They are only diluted with water-glass solution before application on the walls. The two solutions are generally slightly dissimilar in their composition, the former containing less silicic acid, but more alkali, than the latter, which is necessary for the better preservation of the paint. Suitable pigments are zinc white, ocher with its different shades of light yellow, red, and dark brown, black consisting of a mixture of manganese and lampblack, etc., etc. White lead cannot be used, as it coagulates with the water glass, nor vermilion, because it fades greatly under the action of the light. The plastering to be coated must be porous, not fresh, but somewhat hardened. Otherwise the caustic lime of the plaster will quickly decompose the water glass. This circumstance may account for the unsatisfactory results which have frequently been obtained with water-glass coatings. Before applying the paint the wall should first be impregnated with a water-glass solution. The colors may be kept on hand ground, but must be protected from contact with the air. If air is admitted a partial separation of silica in the form of a jelly takes place. Only pure potash water glass, or, at least, such as only contains little soda, should be used, as soda will cause efflorescence.

STEREOPTICON SLIDES:
See Photography.

STEREOTYPE METAL:
See Alloys.

STONE, ARTIFICIAL.

The following is a process of manufacture in which the alkaline silicates prepared industrially are employed.

The function of the alkaline silicates, or soluble glass, as constituents of artificial stone, is to act as a cement, forming with the alkaline earths, alumina, and oxide of lead, insoluble silicates, which weld together the materials (quartz sand, pebbles, granite, fluorspar, and the waste of clay bricks). The mass may be colored black by the addition of a quantity of charcoal or graphite to the extent of 10 per cent at the maximum, binoxide of manganese, or ocher; red, by 6 per cent of colcothar; brick red, by 4 to 7 per cent of cinnabar; orange, by 6 to 8 per cent of red lead; yellow, by 6 per cent of yellow ocher, or 5 per cent of chrome yellow; green, by 8 per cent of chrome green; blue, by 6 to 10 per cent of Neuwied blue, Bremen blue, Cassel blue, or Napoleon blue; and white, by 20 per cent, at the maximum, of zinc white.

Chrome green and zinc oxide produce an imitation of malachite. An imitation of lapis lazuli is obtained by the simultaneous employment of Cassel blue and pyrites in grains. The metallic oxides yield the corresponding silicates, and zinc oxide, mixed with cleansed chalk, yields a brilliant marble. The ingredients are mixed in a kind of mechanical kneading trough, furnished with stirrers, in variable proportions, according to the percentage of the solution of alkaline silicate. The whole is afterwards molded or compressed by the ordinary processes.

The imitation of granite is obtained by mixing lime, 100 parts; sodium silicate (42° Bé.), 35 parts; fine quartz sand, 120 to 180 parts; and coarse sand, 180 to 250 parts.

Artificial basalt may be prepared by adding potassium sulphite and lead acetate, or equal parts of antimony ore and iron filings.

To obtain artificial marble, 100 pounds of marble dust or levigated chalk are mixed with 20 parts of ground glass and 8 parts of fine lime and sodium silicate. The coloring matter is mixed in proportion depending on the effect to be produced.

A fine product for molding is obtained by mixing alkaline silicate, 100 parts; washed chalk, 100 parts; slaked lime, 40 parts; quick lime, 40 parts, fine quartz sand, 200 parts; pounded glass, 80 parts; infusorial earths, 80 parts; fluorspar, 150 parts. On hardening, there is much contraction.

Other kinds of artificial stone are prepared by mixing hydraulic lime or cement, 50 parts; sand, 200 parts; sodium silicate, in dry powder, 50 parts; the whole is moistened with 10 per cent of water and molded.

A hydraulic cement may be employed, to which an alkaline silicate is added. The stone or object molded ought to be covered with a layer of fluosilicate.

A weather-proof water-resisting stone is manufactured from sea mud, to which 5 per cent of calcic hydrate is added. The mass is then dried, lixiviated, and dried once more at 212° F., whereupon the stones are burned. By an admixture of crystallized iron sulphate the firmness of these stones is still increased.

Sand-Lime Brick.—In a French patent for making bricks from pitch and coal tar, powdered coke and sea sand are gently heated in a suitable vessel, and 20 per cent of pitch and 10 per cent of coal tar added, with stirring. The pasty mass obtained is then molded under pressure. The product obtained may be employed alone, or together with a framework of iron, or with hydraulic lime or cement.

According to a French patent for veining marble, etc., in one or more colors, coloring matters of all kinds are mixed with a sticky liquid, which is then spread in a very thin layer on the surface of another immiscible and heavier liquid. By agitating the surface, colored veins, etc., are obtained, which are then transferred to the object to be decorated (which may be of most varied kind) by applying it to the surface of the heavy liquid. A suitable composition with which the colors may be mixed consists of: Oil of turpentine, 100 parts; colophony, 10 parts; linseed oil, 10 parts; *siccatif soleil*, 5 parts. The heavy liquid may be water, mercury, etc.; and any colors, organic or mineral, may be used.

CONCRETE.

Concrete is the name applied to an artificial combination of various mineral substances which under chemical action become incorporated into a solid mass. There are one or two compositions of comparatively trifling importance which receive the same name, though differing fundamentally from true concrete, their solidification being independent of chemical influence. These compositions only call for passing mention; they are: *Tar concrete*, made of broken stones (macadam) and tar; *iron concrete*, composed of iron turnings, asphalt, bitumen, and pitch; and *lead concrete*, consisting of broken bricks set in molten lead. The last two varieties, with rare exceptions, are only used in connection with military engineering, such as for fortifications.

Concrete proper consists essentially of two groups or classes of ingredients. The first, termed the *aggregate*, is a heterogeneous mass, in itself inactive, of mineral material, such as shingle, broken stone, broken brick, gravel, and sand. These are the substances most commonly in evidence, but other ingredients are also occasionally employed, such as slag from iron furnaces. Burnt clay, in any form, and earthenware, make admirable material for incorporation. The second class constitutes the active agency which produces adhesion and solidification. It is termed the matrix, and consists of hydraulic lime or cement, combined with water.

One of the essential features in good concrete is cleanliness and an entire absence of dirt, dust, greasy matter, and impurities of any description. The material will preferably be sharp and angular, with a rough, porous surface, to which the matrix will more readily adhere than to smooth, vitreous substances. The specific gravity of the aggregate will depend upon the purpose for which the concrete is to be used. For beams and lintels, a light aggregate, such as coke breeze from gasworks, is permissible, especially when the work is designed to receive nails. On the other hand, for retaining walls, the heaviest possible aggregate is desirable on the ground of stability.

The aggregate by no means should be uniform in size. Fragments of different dimensions are most essential, so that the smaller material may fill up the interstices of the larger. It is not infrequently stipulated by engineers that no individual fragment shall be more than 4 inches across, and the material is often specified to pass through a ring $1\frac{1}{2}$ to 2 inches in diameter. The absolute limits to size for the aggregate, however, are determinable by a number of considerations, not the least important of which is the magnitude and bulk of the work in which it is to be employed. The particles of sand should also be of varying degrees of coarseness. A fine, dust-like sand is objectionable; its minute subdivision prevents complete contact with the cement on all its faces. Another desideratum is that the particles should not be too spherical, a condition brought about by continued attrition. Hence, pit sand is better in many cases than river sand or shore sand.

The matrix is almost universally Portland cement. It should not be used in too hot a condition, to which end it is usually spread over a wooden floor to a depth of a few inches, for a few days prior to use. By this means, the aluminate of lime becomes partially hydrated, and its activity is thereby modified.

Roman cement and hydraulic lime may also be used as matrices.

Portland cement will take a larger proportion of sand than either Roman cement or hydraulic lime; but with the larger ratios of sand, its tenacity is, of course, correspondingly reduced. One part of cement to 4 parts of sand should therefore be looked upon as the upper limit, while for the strongest mortar the proportion need hardly exceed 1 part of cement to $1\frac{1}{2}$ or 2 parts of sand. In the ensuing calculations there is assumed a ratio of 1 to 3. For impermeability, the proportion of 1 to 2 should be observed, and for Roman cement this proportion should never be exceeded. The ratio will even advantageously be limited to 2 to 3. For hydraulic lime equal parts of sand and cement are suitable, though 2 parts of sand to 1 part of cement may be used.

The quantity of mortar required in reference to the aggregate is based on the vacuities in the latter. For any particular aggregate the amount of empty space may be determined by filling a tank of known volume with the minerals and then adding sufficient water to bring to a level surface. The volume of water added (provided, of course, the aggregate be impervious or previously saturated) gives the net volume of mortar required. To this it is necessary to make some addition (say 10 per cent of the whole), in order to insure the thorough flushing of every part of the work.

Assuming that the proportion of interstices is 30 per cent and adding 10 for the reason just stated, we derive 40 parts as the quantity of mortar to $100 - 10 = 90$ parts of the aggregate. An allowance of $\frac{1}{3}$ volume for shrinkage brings the volume of the dry materials (sand and cement) of the mortar to $40 + 40/3 = 53\frac{1}{3}$ parts, which, divided in the ratio of 1 to 3, yields:

Cement $\frac{53\frac{1}{3}}{4}$ = ...	$13\frac{1}{3}$ parts
Sand, $\frac{3}{4} \times 53\frac{1}{3}$ = ...	40 parts
Aggregate..........	90 parts
Total..........	$143\frac{1}{3}$ parts

As the resultant concrete is 100 parts, the total shrinkage is 30 per cent. Expressed in terms of the cement, the concrete would have a composition of 1 part cement, 3 parts sand, 7 parts gravel and broken stone, and it would form, approximately, what is commonly known as 7 to 1 concrete.

There are other ratios depending on the proportion of sand. Thus we have:

Cement	Sand	Aggregate
1	$1\frac{1}{2}$	$4\frac{1}{3}$
1	2	5
1	$2\frac{1}{2}$	6
1	3	7
1	$3\frac{1}{2}$	$7\frac{1}{2}$
1	4	$8\frac{1}{4}$

The cost of concrete may be materially reduced without affecting the strength or efficacy of the work, by a plentiful use of stone "plums" or "burrs." These are bedded in the fluid concrete during its deposition *in situ*, but care must be taken to see that they are thoroughly surrounded by mortar and not in contact with each other. Furthermore, if they are of a porous nature, they should be well wetted before use.

The mixing of concrete is important. If done by hand, the materials forming the aggregate will be laid out on a platform and covered by the cement in a thin layer. The whole should be turned over thrice in the dry state, and as many times wet, before depositing, in order to bring about thorough and complete amalgamation. Once mixed, the concrete is to be deposited immediately and allowed to remain undisturbed until the action of setting is finished. Deposition should be effected, wherever possible, without tipping from a height of more than about 6 feet, as in greater falls there is a likelihood of the heavier portions of the aggregate separating from the lighter. In extensive undertakings, concrete is more economically mixed by mechanical appliances.

The water used for mixing may be either salt or fresh, so far as the strength of the concrete is concerned. For surface work above the ground level, salinity in any of the ingredients is objectionable, since it tends to produce efflorescence—an unsightly, floury deposit, difficult to get rid of. The quantity of water required cannot be stated with exactitude; it will depend upon the proportion of the aggregate and its porosity. It is best determined by experiment in each particular case. Without being profuse enough to "drown" the concrete, it should be plentiful enough to act as an efficient intermediary between every particle of the aggregate and every particle of the matrix. Insufficient moisture is, in fact, as deleterious as an excess.

Voids.—The strength of concrete depends greatly upon its density, and this is secured by using coarse material which contains the smallest amount of voids or empty spaces. Different kinds of sand,

gravel, and stone vary greatly in the amount of voids they contain, and by judiciously mixing coarse and fine material the voids may be much reduced and the density increased. The density and percentage of voids in concrete material may be determined by filling a box of 1 cubic foot capacity and weighing it. One cubic foot of solid quartz or limestone, entirely free from voids, would weigh 165 pounds, and the amount by which a cubic foot of any loose material falls short of this weight represents the proportion of voids contained in it. For example, if a cubic foot of sand weighs 115½ pounds, the voids would be 49½-165ths of the total volume, or 30 per cent.

The following table gives the per cent of voids and weight per cubic foot of some common concrete materials:

	Per Cent Voids	Wt. per Cu. Ft.
Sandusky Bay sand	32.3	111.7 pounds
Same through 20-mesh screen	38.5	101.5 pounds
Gravel, ⅛ to ¼ inch	42.4	95.0 pounds
Broken limestone, egg-size	47.0	87.4 pounds
Limestone screenings, dust to ½ inch	26.0	122.2 pounds

It will be noted that screening the sand through a 20-mesh sieve, and thus taking out the coarse grains, considerably increased the voids and reduced the weight; thus decidedly injuring the sand for making concrete.

The following figures show how weight can be increased and voids reduced by mixing fine and coarse material:

	Per Cent Voids	Wt. per Cu. Ft.
Pebbles, about 1 inch	38.7	101.2 pounds
Sand, 30 to 40 mesh	35.9	105.8 pounds
Pebbles plus 38.7 per cent sand, by vol.	19.2	133.5 pounds

Experiments have shown that the strength of concrete increases greatly with its density; in fact, a slight increase in weight per cubic foot adds very decidedly to the strength.

The gain in strength obtained by adding coarse material to mixtures of cement and sand is shown in the following table of results of experiments made in Germany by R. Dykerhoff. The blocks tested were 2½-inch cubes, 1 day in air and 27 days in water.

Proportions by Measure.			Per Cent. Cement.	Compression Strength.
Cement.	Sand.	Gravel.	By Volume.	Lbs. per Sq. In.
1	2	...	33.0	2,125
1	2	5	12.5	2,387
1	3	...	25.0	1,383
1	3	6½	9.5	1,515
1	4	...	20.0	1,053
1	4	8½	7.4	1,204

These figures show how greatly the strength is improved by adding coarse material, even though the proportion of cement is thereby reduced. A mixture of 1 to 12½ of properly proportioned sand and gravel is, in fact, stronger than 1 to 4, and nearly as strong as 1 to 3, of cement and sand only.

In selecting materials for concrete, those should be chosen which give the greatest density. If it is practicable to mix two materials, as sand and gravel, the proportion which gives the greatest density should be determined by experiment, and rigidly adhered to in making concrete, whatever proportion of cement it is decided to use. Well-proportioned dry sand and gravel or sand and broken stone, well shaken down, should weigh at least 125 pounds per cubic foot. Limestone screenings, owing to minute pores in the stone itself, are somewhat lighter, though giving equally strong concrete. They should weigh at least 120 pounds per cubic foot. If the weight is less, there is probably too much fine dust in the mixture.

The density and strength of concrete are also greatly improved by use of a liberal amount of water. Enough water must be used to make the concrete thoroughly soft and plastic, so as to quake strongly when rammed. If mixed too dry it will never harden properly, and will be light, porous, and crumbling.

Thorough mixing of concrete materials is essential, to increase the density and give the cement used a chance to produce its full strength. The cement, sand, and gravel should be intimately mixed dry, then the water added and the mixing continued. If stone or coarse gravel is added, this should be well wetted and thoroughly mixed with the mortar.

Materials for Concrete Building Blocks.—In the making of building blocks the spaces to be filled with concrete are generally too narrow to permit the use of very coarse material, and the block-

maker is limited to gravel or stone not exceeding ½ or ¾ inch in size. A considerable proportion of coarse material is, however, just as necessary as in other kinds of concrete work, and gravel or screenings should be chosen which will give the greatest possible density. For good results, at least one-third of the material, by weight, should be coarser than ⅛ inch. Blocks made from such gravel or screenings, 1 to 5, will be found as good as 1 to 3 with sand only. It is a mistake to suppose that the coarse fragments will show on the surface; if the mixing is thorough this will not be the case. A moderate degree of roughness or variety in the surface of blocks is, in fact, desirable, and would go far to overcome the prejudice which many architects hold against the smooth, lifeless surface of cement work. Sand and gravel are, in most cases, the cheapest material to use for block work. The presence of a few per cent of clay or loam is not harmful provided the mixing is thorough. Stone screenings, if of good quality, give fully as strong concrete as sand and gravel, and usually yield blocks of somewhat lighter color. Screenings from soft stone should be avoided, also such as contain too much dust. This can be determined from the weight per cubic foot, and by a sifting test. If more than two-thirds pass ⅛ inch, and the weight (well jarred down) is less than 120 pounds, the material is not the best.

Cinders are sometimes used for block work; they vary greatly in quality, but if clean and of medium coarseness will give fair results. Cinder concrete never develops great strength, owing to the porous character and crushability of the cinders themselves. Cinder blocks may, however, be strong enough for many purposes, and suitable for work in which great strength is not required.

Lime.—It is well known that slaked lime is a valuable addition to cement mortar, especially for use in air. In sand mixtures, 1 to 4 or 1 to 5, at least one-third of the cement may be replaced by slaked lime without loss of strength. The most convenient form of lime for use in block-making is the dry-slaked or hydrate lime, now a common article of commerce. This is, however, about as expensive as Portland cement, and there is no great saving in its use. Added to block concrete, in the proportion of ¼ to ⅓ the cement used, it will be found to make the blocks lighter in color, denser, and decidedly less permeable by water.

Cement.—Portland cement is the only hydraulic material to be seriously considered by the blockmaker. Natural and slag cements and hydraulic lime are useful for work which remains constantly wet, but greatly inferior in strength and durability when exposed to dry air. A further advantage of Portland cement is the promptness with which it hardens and develops its full strength; this quality alone is sufficient to put all other cements out of consideration for block work.

Proportions.—There are three important considerations to be kept in view in adjusting the proportions of materials for block concrete—strength, permeability, and cost. So far as strength goes, it may easily be shown that concretes very poor in cement, as 1 to 8 or 1 to 10, will have a crushing resistance far beyond any load that they may be called upon to sustain. Such concretes are, however, extremely porous, and absorb water like a sponge. The blocks must bear a certain amount of rough handling at the factory and while being carted to work and set up in the wall. Safety in this respect calls for a much greater degree of hardness than would be needed to bear the weight of the building. Again, strength and hardness, with a given proportion of cement, depend greatly on the character of the other materials used; blocks made of cement and sand, 1 to 3, will not be so strong or so impermeable to water as those made from a good mixed sand and gravel, 1 to 5. On the whole, it is doubtful whether blocks of satisfactory quality can be made, by hand mixing and tamping, under ordinary factory conditions, from a poorer mixture than 1 to 5. Even this proportion requires for good results the use of properly graded sand and gravel or screenings, a liberal amount of water, and thorough mixing and tamping. When suitable gravel is not obtainable, and coarse mixed sand only is used, the proportion should not be less than 1 to 4. Fine sand alone is a very bad material, and good blocks cannot be made from it except by the use of an amount of cement which would make the cost very high.

The mixtures above recommended, 1 to 4 and 1 to 5, will necessarily be somewhat porous, and may be decidedly so if the gravel or screenings used is not properly graded. The water-resisting qualities may be greatly improved, without loss of strength, by replacing a part of the cement by hydrate lime. This is a light, extremely fine material, and a given weight of it goes much further than the

same amount of cement in filling the pores of the concrete. It has also the effect of making the wet mixture more plastic and more easily compacted by ramming, and gives the finished blocks a lighter color.

The following mixtures, then, are to be recommended for concrete blocks. By "gravel" is meant a suitable mixture of sand and gravel, or stone screenings, containing grains of all sizes, from fine to ½ inch.

1 to 4 Mixtures, by Weight.

Cement, 150 parts; gravel, 600 parts.

Cement, 125 parts; hydrated lime, 25 parts; gravel, 600 parts.

Cement, 100 parts; hydrated lime, 50 parts; gravel, 600 parts.

1 to 5 Mixtures, by Weight.

Cement, 120 parts; gravel, 600 parts.

Cement, 100 parts; hydrated lime, 20 parts; gravel, 600 parts.

Proportion of Water.—This is a matter of the utmost consequence, and has more effect on the quality of the work than is generally supposed. Blocks made from too dry concrete will always remain soft and weak, no matter how thoroughly sprinkled afterwards. On the other hand, if blocks are to be removed from the machine as soon as made, too much water will cause them to stick to the plates and sag out of shape. It is perfectly possible, however, to give the concrete enough water for maximum density and first-class hardening properties, and still to remove the blocks at once from the mold. A good proportion of coarse material allows the mixture to be made wetter without sticking or sagging. Use of plenty of water vastly improves the strength, hardness, and waterproof qualities of blocks, and makes them decidedly lighter in color. The rule should be:

Use as much water as possible without causing the blocks to stick to the plates or to sag out of shape on removing from the machine.

The amount of water required to produce this result varies with the materials used, but is generally from 8 to 9 per cent of the weight of the dry mixture. A practiced blockmaker can judge closely when the right amount of water has been added, by squeezing some of the mixture in the hand. Very slight variations in proportion of water make such a marked difference in the quality and color of the blocks that the water, when the proper quantity for the materials used has been determined, should always be accurately measured out for each batch. In this way much time is saved and uncertainty avoided.

Facing. — Some blockmakers put on a facing of richer and finer mixture, making the body of the block of poorer and coarser material. As will be explained later, the advantage of the practice is, in most cases, questionable, but facings may serve a good purpose in case a colored or specially waterproof surface is required. Facings are generally made of cement and sand, or fine screenings, passing a ⅛-inch sieve. To get the same hardness and strength as a 1 to 5 gravel mixture, at least as rich a facing as 1 to 3 will be found necessary. Probably 1 to 2 will be found better, and if one-third the cement be replaced by hydrate lime the waterproof qualities and appearance of the blocks will be improved. A richer facing than 1 to 2 is liable to show greater shrinkage than the body of the block, and to adhere imperfectly or develop hair-cracks in consequence.

Poured Work.—The above suggestions on the question of proportions of cement, sand, and gravel for tamped blocks apply equally to concrete made very wet, poured into the mold, and allowed to harden a day or longer before removing. Castings in a sand mold are made by the use of very liquid concrete; sand and gravel settle out too rapidly from such thin mixtures, and rather fine limestone screenings are generally used.

Mixing.—To get the full benefit of the cement used it is necessary that all the materials shall be very thoroughly mixed together. The strength of the block as a whole will be only as great as that of its weakest part, and it is the height of folly, after putting a liberal measure of cement, to so slight the mixing as to get no better result than half as much cement, properly mixed, would have given. The poor, shoddy, and crumbly blocks turned out by many small-scale makers owe their faults chiefly to careless mixing and use of too little water, rather than to too small proportion of cement.

The materials should be mixed dry, until the cement is uniformly distributed and perfectly mingled with the sand and gravel or screenings; then the water is to be added and the mixing continued until all parts of the mass are equally moist and every particle is coated with the cement paste.

Concrete Mixers.—Hand mixing is always imperfect, laborious, and slow

and it is impossible by this method to secure the thorough stirring and kneading action which a good mixing machine gives. If a machine taking 5 or 10 horse-power requires 5 minutes to mix one-third of a yard of concrete, it is of course absurd to expect that two men will do the same work by hand in the same time. And the machine never gets tired or shirks if not constantly urged, as it is the nature of men to do. It is hard to see how the manufacture of concrete blocks can be successfully carried on without a concrete mixer. Even for a small business it will pay well in economy of labor and excellence of work to install such a machine, which may be driven by a small electric motor or gasoline engine. In work necessarily so exact as this, requiring perfectly uniform mixtures and use of a constant percentage of water, batch mixers, which take a measured quantity of material, mix it, and discharge it, at each operation, are the only satisfactory type, and continuous mixers are unsuitable. Those of the pug-mill type, consisting of an open trough with revolving paddles and bottom discharge, are positive and thorough in their action, and permit the whole operation to be watched and controlled. They should be provided with extensible arms of chilled iron, which can be lengthened as the ends become worn.

Concrete Block Systems.—For smaller and less costly buildings, *separate blocks*, made at the factory and built up into the walls in the same manner as brick or blocks of stone, are simpler, less expensive, and much more rapid in construction than monolithic work. They also avoid some of the faults to which solid concrete work, unless skillfully done, is subject, such as the formation of shrinkage cracks.

There are two systems of block making, differing in the consistency of the concrete used:

1. Blocks tamped or pressed from semi-wet concrete, and removed at once from the mold.

2. Blocks poured or tamped from wet concrete, and allowed to remain in the mold until hardened.

Tamped Blocks from Semi-Wet Mixture.—These are practically always made on a block machine, so arranged that as soon as a block is formed the cores and side plates are removed and the block lifted from the machine. By far the larger part of the blocks on the market are made in this way. Usually these are of the one-piece type, in which a single block, provided with hollow cores, makes the whole thickness of the wall. Another plan is the *two-piece* system, in which the face and back of the wall are made up of different blocks, so lapping over each other as to give a bond and hold the wall together. Blocks of the two-piece type are generally formed in a hand or hydraulic press.

Various shapes and sizes of blocks are commonly made; the builders of the most popular machines have, however, adopted the standard length of 32 inches and height of 9 inches for the full-sized block, with thickness of 8, 10, and 12 inches. Lengths of 24, 16, and 8 inches are also obtained on the same machines by the use of parting plates and suitably divided face plates; any intermediate lengths and any desired heights may be produced by simple adjustments or blocking off.

Blocks are commonly made plain, rock-faced, tool-faced, paneled, and of various ornamental patterns. New designs of face plates are constantly being added by the most progressive machine makers.

Block Machines.—There are many good machines on the market, most of which are of the same general type, and differ only in mechanical details. They may be divided into two classes: those with vertical and those with horizontal face. In the former the face plate stands vertically, and the block is simply lifted from the machine on its base plate as soon as tamped. In the other type the face plate forms the bottom of the mold; the cores are withdrawn horizontally, and by the motion of a lever the block with its face plate is tipped up into a vertical position for removal. In case it is desired to put a facing on the blocks, machines of the horizontal-face type are considered the more convenient, though a facing may easily be put on with the use of a vertical-face machine by the use of a parting plate.

Blocks Poured from Wet Concrete.—As already stated, concrete made too dry is practically worthless, and an excess of water is better than a deficiency. The above-described machine process, in which blocks are tamped from damp concrete and at once removed, gives blocks of admirable hardness and quality if the maximum of water is used. A method of making blocks from very wet concrete, by the use of a large number of separable molds of sheet steel, into which the wet concrete is poured and in which the blocks are left to harden for 24

hours or longer, has come into considerable use. By this method blocks of excellent hardening and resistance to water are certainly obtained. Whether the process is the equal of the ordinary machine method in respect of economy and beauty of product must be left to the decision of those who have had actual experience with it.

The well-known cast-stone process consists in pouring liquid concrete mixture into a sand mold made from a pattern in a manner similar to that in which molds for iron castings are produced. The sand absorbs the surplus water from the liquid mixture, and the casting is left in the mold for 24 hours or longer until thoroughly set. This process necessitates the making of a new sand mold for every casting, and is necessarily much less rapid than the machine method. It is less extensively used for building blocks than for special ornamental architectural work, sills, lintels, columns, capitals, etc., and for purposes of this kind it turns out products of the highest quality and beauty.

Tamping of Concrete Blocks. — This is generally done by means of hand rammers. Pneumatic tampers, operated by an air compressor, are in use at a few plants, apparently with considerable saving in time and labor and improvements in quality of work. Hand tamping must be conscientious and thorough, or poor work will result. It is important that the mold should be filled a little at a time, tamping after each addition; at least four fillings and tampings should be given to each block. If the mixture is wet enough no noticeable layers will be formed by this process.

Hardening and Storage. — Triple-decked cars to receive the blocks from the machines will be found a great saving of labor, and are essential in factories of considerable size. Blocks will generally require to be left on the plates for at least 24 hours, and must then be kept under roof, in a well-warmed room, with frequent sprinkling, for not less than 5 days more. They may then be piled up out of doors, and in dry weather should be wetted daily with a hose. Alternate wetting and drying is especially favorable for the hardening of cement, and concrete so treated gains much greater strength than if kept continuously in water or dry air.

Blocks should not be used in building until at least 4 weeks from the time they are made. During this period of seasoning, blocks will be found to shrink at least $\frac{1}{16}$ inch in length, and if built up in a wall when freshly made, shrinkage cracks in the joints or across the blocks will surely appear.

Efflorescence, or the appearance of a white coating on the surfaces, sometimes takes place when blocks are repeatedly saturated with water and then dried out; blocks laid on the ground are more liable to show this defect. It results from diffusion of soluble sulphates of lime and alkalies to the surface. It tends to disappear in time, and rarely is sufficient in amount to cause any complaint.

Properties of Concrete Blocks — Strength.—In the use of concrete blocks for the walls of buildings. the stress to which they are subjected is almost entirely one of compression. In compressive strength well-made concrete does not differ greatly from ordinary building stone. It is difficult to find reliable records of tests of sand and gravel concrete, 1 to 4 and 1 to 5, such as is used in making blocks; the following figures show strength of concrete of approximately this richness, also the average of several samples each of well-known building stones, as stated by the authorities named:

Limestone, Bedford, Ind. (Indiana Geographical Survey)	7,792 pounds
Limestone, Marblehead, Ohio (Q. A. Gillmore)	7,393 pounds
Sandstone, N. Amherst, Ohio (Q. A. Gillmore)	5,831 pounds
Gravel concrete, 1:1.6-:2.8, at 1 year (Candlot)	5,500 pounds
Gravel concrete, 1:1.6-:3.7, at 1 year (Candlot)	5,050 pounds
Stone concrete, 1:2:4 at 1 year (Boston El. R. R.)	3,904 pounds

Actual tests of compression strength of hollow concrete blocks are difficult to make, because it is almost impossible to apply the load uniformly over the whole surface, and also because a block 16 inches long and 8 inches wide will bear a load of 150,000 to 200,000 pounds, or more than the capacity of any but the largest testing machines. Three one-quarter blocks, 8 inches long, 8 inches wide, and 9 inches high, with hollow space equal to one-third of the surface, tested at the Case School of Science, showed strengths of 1,805, 2,000, and

1,530 pounds per square inch, respectively, when 10 weeks old.

Two blocks $6 \times 8 \times 9$ inches, 22 months old, showed crushing strength of 2,530 and 2,610 pounds per square inch. These blocks were made of cement $1\frac{1}{4}$ parts, lime $\frac{1}{2}$ part, sand and gravel 6 parts, and were tamped from damp mixture. It is probably safe to assume that the minimum crushing strength of well-made blocks, 1 to 5, is 1,000 pounds per square inch at 1 month and 2,000 pounds at 1 year.

A block 12 inches wide and 24 inches long has a total surface of 288 square inches, or, deducting $\frac{1}{3}$ for openings, a net area of 192 inches. Such a block, 9 inches high, weighs 130 pounds. Assuming a strength of 1,000 pounds and a factor of safety of 5, the safe load would be 200 pounds per square inch, or $200 \times 192 = 38{,}400$ pounds for the whole surface of the block. Dividing this by the weight of the block, 130 pounds, we find that 295 such blocks could be placed one upon another, making a total height of wall of 222 feet, and still the pressure on the lowest block would be less than one-fifth of what it would actually bear. This shows how greatly the strength of concrete blocks exceeds any demands that are ever made upon it in ordinary building construction.

The safe load above assumed, 200 pounds, seems low enough to guard against any possible failure. In Taylor and Thompson's work on concrete, a safe load of 450 pounds for concrete 1 to 2 to 4 is recommended; this allows a factor of safety of $5\frac{1}{3}$. On the other hand, the Building Code of the city of Cleveland permits concrete to be loaded only to 150 pounds per square inch, and limits the height of walls of 12-inch blocks to 44 feet. The pressure of such a wall would be only 40 pounds per square inch; adding the weight of two floors at 25 pounds per square foot each, and roof with snow and wind pressure, 40 pounds per square foot, we find that with a span of 25 feet the total weight on the lowest blocks would be only 52 pounds per square inch, or about one-twentieth of their minimum compression strength.

Blocks with openings equal to only one-third the surface, as required in many city regulations, are heavy to handle, especially for walls 12 inches and more in thickness, and, as the above figures show, are enormously stronger than there is any need of. Blocks with openings of 50 per cent would be far more acceptable to the building trade, and if used in walls not over 44 feet high, with floors and roof calculated as above for 25 feet span, would be loaded only to 56 pounds per square inch of actual surface. This would give a factor of safety of 18, assuming a minimum compression strength of 1,000 pounds.

There is no doubt that blocks with one-third opening are inconveniently and unnecessarily heavy. Such a block, 32 inches long, 12 inches wide, and 9 inches high, has walls about $3\frac{1}{2}$ inches thick, and weighs 180 pounds. A block with 50 per cent open space would have walls and partitions 2 inches in thickness, and would weigh about 130 pounds. With proper care in manufacture, especially by using as much water as possible, blocks with this thickness of walls may be made thoroughly strong, sound, and durable. It is certainly better for strength and water-resisting qualities to make thin-walled blocks of rich mixture, rather than heavy blocks of poor and porous material.

Filling the voids with cement is a rather expensive method of securing waterproof qualities, and gives stronger concretes than are needed. The same may be accomplished more cheaply by replacing part of the cement by slaked lime, which is an extremely fine-grained material, and therefore very effective in closing pores. Hydrate lime is the most convenient material to use, but nearly as costly as Portland cement at present prices. A 1 to 4 mixture in which one-third the cement is replaced by hydrate lime will be found equal to a 1 to 3 mixture without the lime. A 1 to 4 concrete made from cement, 1; hydrate lime, $\frac{1}{2}$; sand and gravel, 6 (by weight), will be found fairly water-tight, and much superior in this respect to one of the same richness consisting of cement, $1\frac{1}{2}$; sand and gravel, 6.

The cost of lime may be greatly reduced by using ordinary lump lime slaked to a paste. The lime must, however, be very thoroughly hydrated, so that no unslaked fragments may remain to make trouble by subsequent expansion. Lime paste is also very difficult to mix, and can be used successfully only in a concrete mixer of the pug-mill type. Ordinary stiff lime paste contains about 50 per cent water; twice as much of it, by weight, should therefore be used as of dry hydrate lime.

Waterproof Qualities.—The chief fault of concrete building blocks, as ordinarily made, is their tendency to absorb water. In this respect they are generally no

worse than sandstone or common brick; it is well known that stone or brick walls are too permeable to allow plastering directly on the inside surface, and must be furred and lathed before plastering, to avoid dampness. This practice is generally followed with concrete blocks, but their use and popularity would be greatly increased if they were made sufficiently waterproof to allow plastering directly on the inside surface.

For this purpose it is not necessary that blocks should be perfectly waterproof, but only that the absorption of water shall be *slow*, so that it may penetrate only part way through the wall during a long-continued rain. Walls made entirely water-tight are, in fact, objectionable, owing to their tendency to "sweat" from condensation of moisture on the inside surface. For health and comfort, walls must be slightly porous, so that any moisture formed on the inside may be gradually absorbed and carried away.

Excessive water absorption may be avoided in the following ways:

1. Use of Properly Graded Materials.—It has been shown by Feret and others that porosity and permeability are two different things; porosity is the total proportion of voids or open spaces in the mass, while permeability is the rate at which water, under a given pressure, will pass through it. Permeability depends on the *size* of the openings as well as on their total amount. In two masses of the same porosity or percentage of voids, one consisting of coarse and the other of fine particles, the permeability will be greater in the case of the coarse material. The least permeability, and also the least porosity, are, however, obtained by use of a suitable mixture of coarse and fine particles. Properly graded gravel or screenings, containing plenty of coarse fragments and also enough fine material to fill up the pores, will be found to give a much less permeable concrete than fine or coarse sand used alone.

2. Use of Rich Mixtures.—All concretes are somewhat permeable by water under sufficient pressure. Mixtures rich in cement are of course much less permeable than poorer mixtures. If the amount of cement used is more than sufficient to fill the voids in the sand and gravel, a very dense concrete is obtained, into which the penetration of water is extremely slow. The permeability also decreases considerably with age, owing to the gradual crystallization of the cement in the pores, so that concrete which is at first quite absorbent may become practically impermeable after exposure to weather for a few weeks or months. There appears to be a very decided increase in permeability when the cement is reduced below the amount necessary to fill the voids. For example, a well-mixed sand and gravel weighing 123 pounds per cubic foot, and therefore containing 25 per cent voids, will give a fairly impermeable concrete in mixtures up to 1 to 4, but with less cement will be found quite absorbent. A gravel with only 20 per cent voids would give about equally good results with a 1 to 5 mixture; such gravel is, however, rarely met with in practice. On the other hand, the best sand, mixed fine and coarse, seldom contains less than 33 per cent voids, and concrete made from such material will prove permeable if poorer than 1 to 3.

3. Use of a Facing.—Penetration of water may be effectively prevented by giving the blocks a facing of richer mixture than the body. For the sake of smooth appearance, facings are generally made of cement and fine sand, and it is often noticed that these do not harden well. It should be remembered that a 1 to 3 sand mixture is no stronger and little if any better in water absorption than a 1 to 5 mixture of well-graded sand and gravel. To secure good hardness and resistance to moisture a facing as rich as 1 to 2 should be used.

4. Use of an Impervious Partition.—When blocks are made on a horizontal-face machine, it is a simple matter, after the face is tamped and cores pushed into place, to throw into each opening a small amount of rich and rather wet mortar, spread this fairly evenly, and then go on tamping in the ordinary mixture until the mold is filled. A dense layer across each of the cross walls is thus obtained, which effectually prevents moisture from passing beyond it. A method of accomplishing the same result with vertical-face machines, by inserting tapered wooden blocks in the middle of the cross walls, withdrawing these blocks after tamping, and filling the spaces with rich mortar, has been patented. In the two-piece system the penetration of moisture through the wall is prevented by leaving an empty space between the web of the block and the inside face, or by filling this space with rich mortar.

5. Use of Waterproof Compounds.—There are compounds on the market, of a fatty or waxy nature, which, when mixed with cement to the amount of

only 1 or 2 per cent of its weight, increase its water-resisting qualities in a remarkable degree. By thoroughly mixing 1 to 2 pounds of suitable compound with each sack of cement used, blocks which are practically waterproof may be made, at very small additional cost, from 1 to 4 or 1 to 5 mixtures. In purchasing waterproof compound, however, care should be taken to select such as has been proved to be *permanent* in its effect, and some of the materials used for this purpose lose their effect after a few days' exposure to weather, and are entirely worthless.

6. Application to Surface after Erecting.—Various washes, to make concrete and stone impervious to water, have been used with some success. Among these the best known is the Sylvester wash of alum and soap solution. It is stated that this requires frequent renewal, and it is hardly likely to prove of any value in the concrete industry. The writer's experience has been that the most effective remedy, in case a concrete building proves damp, is to give the outside walls a very thin wash of cement suspended in water. One or two coats will be found sufficient. If too thick a coating is formed it will show hair cracks. The effect of the cement wash is to make the walls appear lighter in color, and if the coating is thin the appearance is in no way injured.

General Hints on Waterproof Qualities.—To obtain good water-resisting properties the first precaution is to make the concrete sufficiently wet. Dry-tamped backs, even from rich mixture, will always be porous and absorbent, while the same mixture in plastic condition will give blocks which are dense, strong, and water-tight. The difference in this respect is shown by the following tests of small concrete blocks, made by the writer. The concrete used was made of 1 part cement and 5 parts mixed fine and coarse sand, by weight.

No. 1. With 8 per cent water, rather dryer than ordinary block concrete, tamped in mold.

No. 2. With 10 per cent water, tamped in the mold, and the mold removed at once.

No. 3. With 25 per cent water, poured into a mold resting on a flat surface of dry sand; after 1 hour the surface was troweled smooth; mold not removed until set.

These blocks were allowed to harden a week in moist air, then dried. The weights, voids, and water absorption were as follows:

	1 Damp-tamped	2 Wet-tamped	3 Poured
Weight, per cubic foot, pounds.....	122.2	123.9	110.0
Voids, calculated, per cent of volume	25.9	24.9	33.3
Water required to fill voids, per cent of weight......	9.8	9.4	12.5
Water absorbed, after 2 hours, per cent of weight...	8.8	6.4	10.5

The rate at which these blocks absorbed water was then determined by drying them thoroughly, then placing them in a tray containing water ¼ inch in depth, and weighing them at intervals.

	1 Damp-tamped	2 Wet-tamped	3 Poured
½ hour..........	2.0	0.9	1.8
1 hour..........	3.2	1.1	2.5
2 hours.........	4.1	1.6	3.2
4 hours.........	5.2	2.0	[illegible]
24 hours.........	6.1	3.4	7.0
48 hours.........	6.4	4.3	7.5

These figures show that concrete which is sufficiently wet to be thoroughly plastic absorbs water much more slowly than dryer concrete, and prove the importance of using as much water as possible in the damp-tamping process.

Cost.—Concrete blocks can be sold and laid up at a good profit at 25 cents per cubic foot of wall. Common red brick costs (at this writing) generally about $12 per thousand, laid. At 24 to the cubic foot, a thousand brick are equal to 41.7 cubic foot of wall; or, $12, 29 cents per cubic foot. Brick walls with pressed brick facing cost from 40 cents to 50 cents per cubic foot, and dressed stone from $1 to $1.50 per foot.

The factory cost of concrete blocks varies according to the cost of materials. Let us assume cement to be $1.50 per barrel of 380 pounds, and sand and gravel 25 cents per ton. With a 1 to 4 mixture, 1 barrel cement will make 1,900 pounds of solid concrete, or at 130 pounds per cubic foot, 14.6 cubic feet. The cost of materials will then be:

Cement, 380 pounds..........	$1.50
Sand and gravel, 1,500 pounds...	0.19
Total....................	$1.69

or 11.5 cents per cubic foot solid concrete. Now, blocks 9 inches high and 32 inches long make 2 square feet of face of wall, each. Blocks of this height

and length, 8 inches thick, make $1\frac{1}{3}$ cubic feet of wall; and blocks 12 inches thick make 2 cubic feet of wall. From these figures we may calculate the cost of materials for these blocks, with cores or openings equal to $\frac{1}{3}$ or $\frac{1}{2}$ the total volume, as follows:

Per cubic foot of block, $\frac{1}{3}$ opening	7.7 cts.
Per cubic foot of block, $\frac{1}{2}$ opening	5.8 cts.
Block 8 x 9 x 32 inches, $\frac{1}{3}$ opening	10.3 cts.
Block 8 x 9 x 32 inches, $\frac{1}{2}$ opening	7.7 cts.
Block 12 x 9 x 32 inches, $\frac{1}{3}$ opening	15.4 cts.
Block 12 x 9 x 32 inches, $\frac{1}{2}$ opening	11.6 cts.

If one-third of the cement is replaced by hydrate lime the quality of the blocks will be improved, and the cost of material reduced about 10 per cent. The cost of labor required in manufacturing, handling, and delivering blocks will vary with the locality and the size and equipment of factory. With hand mixing, 3 men at an average of $1.75 each will easily make 75 8-inch or 50 12-inch blocks, with $\frac{1}{3}$ openings, per day. The labor cost for these sizes of blocks will therefore be 7 cents and $10\frac{1}{2}$ cents respectively. At a factory equipped with power concrete mixer and cars for transporting blocks, in which a number of machines are kept busy, the labor cost will be considerably less. An extensive industry located in a large city is, however, subject to many expenses which are avoided in a small country plant, such as high wages, management, office rent, advertising, etc., so that the total cost of production is likely to be about the same in both cases. A fair estimate of total factory cost is as follows:

	Material	Labor	Total
8 x 32 inch, $\frac{1}{3}$ space	10.3	7	17.3 cts.
8 x 32 inch, $\frac{1}{2}$ space	7.7	6	13.7 cts.
12 x 32 inch, $\frac{1}{3}$ space	15.4	10.5	25.9 cts.
12 x 32 inch, $\frac{1}{2}$ space	11.6	9	20.6 cts.

With fair allowance for outside expenses and profit, 8-inch blocks may be sold at 30 cents and 12-inch at 40 cents each. For laying 12-inch blocks in the wall, contractors generally figure about 10 cents each. Adding 5 cents for teaming, the blocks will cost 55 cents each, erected, or $27\frac{1}{2}$ cents per cubic foot of wall. This is less than the cost of common brick, and the above figures show that this price could be shaded somewhat, if necessary, to meet competition.—*S. B. Newberry in a monograph issued by the American Association of Portland Cement Manufacturers.*

Artificial Marbles.—I.—The mass used by Beaumel consists of alum and heavy spar (barium sulphate) with addition of water and the requisite pigments. The following proportions have been found to be serviceable: Alum, 1,000 parts; heavy spar, 10 to 100 parts; water, 100 parts; the amount of heavy spar being governed by the degree of translucence desired. The alum is dissolved in water with the use of heat. As soon as the solution boils the heavy spar is mixed in, stirred with water and the pigment; this is then boiled down until the mixture has lost about 3 per cent of its weight, at which moment the mass exhibits a density of 34° Bé. at a temperature of 212° F. The mixture is allowed to cool with constant stirring until the substance is semi-liquid. The resultant mass is poured into a mold covered on the inside with several layers of collodion and the cast permitted to cool completely in the mold, whereupon it is taken out and dried entirely in an airy room. Subsequently the object may be polished, patinized, or finished in some other way.

II.—**Imitation Black Marble.**—A black marble of similar character to that exported from Belgium—the latter product being simply prepared slate—may be produced in the following manner: The slate suitable for the purpose is first smoothly polished with a sandstone, so that no visible impression is made on it with a chisel—this being rough—after which it is polished finely with artificial pumice stone, and lastly finished with extremely light natural pumice stone, the surface then presenting a soft, velvet-like appearance. After drying and thoroughly heating the finely polished surface is impregnated with a heated mixture of oil and fine lampblack. This is allowed to remain 12 hours; and, according to whether the slate used is more or less gray, the process is repeated until the gray appearance is lost. Polishing thoroughly with emery on a linen rag follows, and the finishing polish is done with tin ashes, to which is added some lampblack. A finish being made thus, wax dissolved in turpentine, with some lampblack, is spread on the polished plate and warmed again, which after a while is rubbed off vigorously with a

clean linen rag. Treated thus, the slate has the appearance of black marble.

STOPPERS:

I.—To make an anti-leak and lubricating mixture for plug-cocks use 2 parts of tried suet and 1 part of beeswax melted together; stir thoroughly, strain, and cool.

II.—A mixture for making glass stoppers tight is made by melting together equal parts of glycerine and paraffine.

To Loosen a Glass Stopper.—I.—Make a mixture of

Alcohol	2 drachms
Glycerine	1 drachm
Sodium chloride ...	1 drachm

Let a portion of this stand in the space above the stopper for a few hours, when a slight tap will loosen the stopper.

II.—A circular adjustable clamp, to which is attached a strip of asbestos in which coils of platinum wire are imbedded, is obtained. By placing this on the neck of the bottle, and passing a current of electricity through the coils of wire, sufficient heat will be generated to expand the neck and liberate the stopper. Heat may also be generated by passing a yard of cord once around the bottle neck and, by taking one end of the cord in each hand, drawing it rapidly back and forth. Care should be taken that the contents of the bottle are not spilled on the hand or thrown into the face when the stopper does come out—or when the bottle breaks.

STOPPER LUBRICANTS:

See Lubricants.

STOVE POLISH:

See also Polishes.

The following formula gives a liquid stove blacking:

Graphite, in fine powder	1 pound
Lampblack	1 ounce
Rosin	4 ounces
Turpentine	1 gallon

The mixture must be well shaken when used, and must not be applied when there is a fire or light near on account of the inflammability of the vapor.

This form may be esteemed a convenience by some, but the rosin and turpentine will, of course, give rise to some disagreeable odor on first heating the stove, after the liquid is applied.

Graphite is the foundation ingredient in many stove polishes; lampblack, which is sometimes added, as in the foregoing formula, deepens the color, but the latter form of carbon is of course much more readily burned off than the former. Graphite may be applied by merely mixing with water, and then no odor follows the heating of the iron. The coating must be well rubbed with a brush to obtain a good luster.

The solid cakes of stove polish found in the market are made by subjecting the powdered graphite, mixed with spirit of turpentine, to great pressure. They have to be reduced to powder and mixed with water before being applied.

Any of them must be well rubbed with a brush after application to give a handsome finish.

STRAW HAT DYEING:

The plan generally followed is that of coating the hats with a solution of varnish in which a suitable aniline dye has dissolved. The following preparations are in use:

I.—For dark varnishes prepare a basis consisting of orange shellac, 900 parts; sandarac, 225 parts; Manila copal, 225 parts; castor oil, 55 parts; and wood-spirit, 9,000 parts. To color, add to the foregoing amount alcohol-soluble, coal-tar dyes as follows: Black, 55 parts of soluble ivory-black (modified by blue or green). Olive-brown, 15 parts of brilliant-green, 55 parts of Bismarck brown R, 8 parts of spirit blue. Olive-green, 28 parts of brilliant-green, 28 parts of Bismarck-brown R. Walnut, 55 parts of Bismarck-brown R. 15 parts of nigrosin. Mahogany, 28 parts of Bismarck-brown R, which may be deepened by a little nigrosin.

II.—For light colors prepare a varnish as follows: Sandarac, 1,350 parts; elemi, 450 parts; rosin, 450 parts; castor oil, 110 parts; wood-spirit, 9,000 parts. For this amount use dyes as follows: Gold, 55 parts of chrysoidin, 55 parts of aniline-yellow. Light green, 55 parts of brilliant-green, 7 parts of aniline-yellow. Blue, 55 parts of spirit blue. Deep blue, 55 parts of spirit blue, 55 parts of indulin. Violet, 28 parts of methyl-violet, 3 B. Crimson, 55 parts of safranin. Chestnut, 55 parts of safranin, 15 parts of indulin.

III.—Shellac	4 ounces
Sandarac	1 ounce
Gum thus	1 ounce
Methyl spirit	1 pint

In this dissolve aniline dyes of the requisite color, and apply. For white straw, white shellac must be used.

STYPTICS.

Styptics are substances which arrest local bleeding. Creosote, tannic acid, alcohol, alum, and most of the astringent salts belong to this class.

Brocchieri's Styptic.—A nostrum consisting of the water distilled from pine tops.

Helvetius's Styptic.—Iron filings (fine) and cream of tartar mixed to a proper consistence with French brandy.

Eaton's Styptic.—A solution of sulphate disguised by the addition of some unimportant substances. Helvetius's styptic was for a long time employed under this title.

Styptic Paste of Gutta Percha.—Gutta percha, 1 ounce; Stockholm tar, 1½ or 2 ounces; creosote, 1 drachm; shellac, 1 ounce; or quantity sufficient to render it sufficiently hard. To be boiled together with constant stirring, till it forms a homogeneous mass. For alveolar hemorrhage, and as a styptic in toothache. To be softened by molding with the fingers.

SWEEPING COMPOUND FOR WOOD FLOORS:

Sawdust	15 pounds
Paraffine oil	½ pint
Powdered wax	1 ounce
Common salt	½ pound
Sand fine	5 pounds
Oil mirbane	½ ounce

Melt the wax and add to the warm paraffine oil—add the oil of mirbane and any aniline color desired. Stir and saturate the sawdust. When thoroughly saturated add the salt and sand and enough sawdust to give your finished product the desired dampness. Put up in small wooden kegs.

Syrups

(See also Essences and Extracts.)

The syrups should either be made from the best granulated sugar, free from ultramarine, or else rock-candy syrup. If the former, pure distilled water should be used in making the syrup, as only in this manner can a syrup be obtained that will be free from impurities and odor. There are two methods by which syrup can be made, namely, by the cold process, or by boiling. The advantage of the former is its convenience; of the latter, that it has better keeping qualities. In the cold process, the sugar is either stirred up in the water until it is dissolved, or water is percolated or filtered through the sugar, thus forming a solution. In the hot process, the sugar is simply dissolved in the water by the aid of heat, stirring until solution is effected. The strength of the syrup for fountain use should be about 6 pounds in the gallon of finished syrup; it is best, however, to make the stock syrup heavier, as it will keep much better, using 15 pounds of granulated sugar, and 1 gallon of water. When wanted for use it can be diluted to the proper density with water. The syrups of the market are of this concentrated variety. Unless the apartments of the dispenser are larger than is usual, it is often best to buy the syrup, the difference in cost being so small that when the time is taken into consideration the profit is entirely lost. Foamed syrups should, however, never be purchased; they are either contaminated with foreign flavor, or are more prone to fermentation than plain syrup.

Fruit Syrups.—These may be prepared from fruit juices, and the desired quantity of syrup, then adding soda foam, color, and generally a small amount of fruit-acid solution. They may also be made by reducing the concentrated fruit syrups of the market with syrup, otherwise proceeding as above. As the fruit juices and concentrated syrups always have a tried formula attached, it is needless to use space for this purpose.

When a flavor is weak it may be fortified by adding a small amount of flavoring extract, but under no condition should a syrup flavored entirely with an essence be handed out to the consumer as a fruit syrup, for there is really no great resemblance between the two. Fruit syrups may be dispensed solid by adding the syrup to the soda water and stirring with a spoon. Use nothing but the best ingredients in making syrups.

Preservation of Syrups.—The preservation of syrups is purely a pharmaceutical question. They must be made right in order to keep right. Syrups, particularly fruit syrups, must be kept aseptic, especially when made without heat. The containers should be made of glass, porcelain, or pure block tin, so that they may be sterilized, and should be easily and quickly removed, so that the operation may be effected with promptness and facility. As is well known, the operation of sterilization is

very simple, consisting in scalding the article with boiling water. No syrup should ever be filled into a container without first sterilizing the container. The fruit acids, in the presence of sugar, serve as a media for the growth and development of germ life upon exposure to the air. Hence the employment of heat as pasteurization and sterilization in the preserving of fruits, etc.

A pure fruit syrup, filled into a glass bottle, porcelain jar, or block-tin can, which has been rendered sterile with boiling water, maintained at a cool temperature, will keep for any reasonable length of time. All danger of fracturing the glass, by pouring water into it, may be obviated by first wetting the interior of the bottle with cold water.

The fruits for syrups must not only be fully ripe, but they must be used immediately after gathering. The fruit must be freed from stems, seeds, etc., filled into lightly tied linen sacks, and thus subjected to pressure, to obtain their juices. Immediately after pressure the juice should be heated quickly to 167° F., and filtered through a felt bag. The filtrate should fall directly upon the sugar necessary to make it a syrup. The heating serves the purpose of coagulating the albuminous bodies present in the juices, and thus to purify the latter.

Syrups thus prepared have not only a most agreeable, fresh taste, but are very stable, remaining in a good condition for years.

Hints on Preparation of Syrups.—Keep the extracts in a cool, dark place. Never add flavoring extracts to hot syrup. It will cause them to evaporate, and weaken the flavor. Keep all the mixing utensils scrupulously clean. Never mix fruit syrups, nor let them stand in the same vessels in which sarsaparilla, ginger, and similar extract flavors are mixed and kept. If possible, always use distilled water in making syrup. Never allow a syrup containing acid to come in contact with any metal except pure block tin. Clean the syrup jars each time before refilling. Keep all packages of concentrated syrups and crushed fruits tightly corked. Mix only a small quantity of crushed fruit in the bowl at a time, so as to have it always fresh.

How to Make Simple Syrups—Hot Process.—Put 25 pounds granulated sugar in a large pail, or kettle, and pour on and stir hot water enough to make 4 gallons, more or less depending on how thick the syrup is desired. Then strain while hot through fine cheese cloth.

Cold Process.—By agitation. Sugar, 25 pounds; water, 2 gallons. Put the sugar in a container, add the water, and agitate with a wooden paddle until the sugar is dissolved. An earthenware jar with a cover and a faucet at the bottom makes a very convenient container.

Cold Process.—By percolation. A good, easy way to keep syrup on hand all the time: Have made a galvanized iron percolator, 2 feet long, 8 inches across top, and 4 inches at base, with a 4-inch wire sieve in bottom. Finish the bottom in shape of a funnel. Put a syrup faucet in a barrel, and set on a box, so that the syrup can be drawn into a gallon measure. Bore a hole in the barrel head, and insert the percolator. Fill three-fourths full of sugar, and fill with water. As fast as the syrup runs into the barrel fill the percolator, always putting in plenty of sugar. By this method 20 to 25 gallons heavy syrup can be made in a day.

Rock-Candy Syrup.—Sugar, 32 pounds; water, 2 gallons. Put the sugar and water in a suitable container, set on stove, and keep stirring until the mixture boils up once. Strain and allow to cool. When cool there will be on top a crust, or film, of crystallized sugar. Strain again to remove this film, and the product will be what is commonly known as rock-candy syrup. This may be reduced with one-fifth of its bulk of water when wanted for use.

COLORS FOR SYRUPS:

Caramel.—Place 3 pounds of crushed sugar in a kettle with 1 pint of water, and heat. The sugar will at first dissolve, but as the water evaporates a solid mass will be formed. This must be broken up.

Continue to heat, with constant stirring, until the mass has again become liquefied. Keep on a slow fire until the mass becomes very dark; then remove the kettle from the fire and pour in slowly 3 pints of boiling water. Set the kettle back on the fire and permit contents to boil for a short time, then remove, and cool. Add simple syrup to produce any required consistency.

Blue.—

I.—Indigo carmine...... 1 part
Water.............. 20 parts

Indigo carmine may usually be obtained commercially;

II.—Tincture of indigo also makes a harmless blue.

Sap Blue.—

Dark blue.........	3 parts
Grape sugar.......	1 part
Water.............	6 parts

Green.—The addition of indigo-carmine solution to any yellow solution will give various shades of green. Indigo carmine added to a mixture of tincture of crocus and glycerine will give a fine green color. A solution of commercial chlorophyll yields grass-green shades.

Pink.—

I.—Carmine...........	1 part
Liquor potassæ......	6 parts
Rose water to make..	48 parts

Mix. If the color is too high, dilute with distilled water until the required tint is obtained.

II.—Soak red-apple parings in California brandy. The addition of rose leaves makes a fine flavoring as well as coloring agent.

Red.—

Carmine, No. 40....	1 part
Strong ammonia water............	4 parts
Distilled water to make	24 parts

Rub up the carmine and ammonia water and to the solution add the water under trituration. If, in standing, this shows a tendency to separate, a drop or two of water of ammonia will correct the trouble. This statement should be put on the label of the bottle as the volatile ammonia soon escapes even in glass-stoppered vials. Various shades of red may be obtained by using fruit juices, such as black cherry, raspberry, etc., and also the tinctures of sudbear, alkanet, red saunders, erythroxylon, etc.

Orange.—

Tincture of red sandalwood.............	1 part
Ethereal tincture of Orlean, q. s.	

Add the orlean tincture to the sandalwood gradually until the desired tint is obtained. A red color added to a yellow one gives an orange color.

Purple.—A mixture of tincture of indigo, or a solution of indigo carmine, added to cochineal red gives a fine purple.

Yellow.—Various shades of yellow may be obtained by the maceration of saffron or turmeric in alcohol until a strong tincture is obtained. Dilute with water until the desired tint is reached.

SYRUP, TABLE:

See Tables.

Tables

ALCOHOL DILUTION.

The following table gives the percentage, by weight, of alcohol of 95 per cent and of distilled water to make 1 liter (about 1 quart), or 1 kilogram (2.2 pounds), of alcohol of various dilutions.

TABLE FOR THE DILUTION OF ALCOHOL.

Percentage by Volume.	1 Liter contains		Specific Gravity at 60° F.	1 Kilogram contains		Percentage by Weight.
	Alcohol 95%.	Distilled Water.		Alcohol 95%.	Distilled Water.	
	Gms.	Gms.		Gms.	Gms.	
5	42.87	950.13	0.993	43.17	956.83	3.99
10	85.89	900.11	0.986	87.11	912.89	8.05
15	128.87	852.13	0.981	131.37	868.63	12.14
20	171.83	804.17	0.976	176.06	823.94	16.27
25	214.77	756.23	0.971	221.18	778.82	20.44
30	257.93	707.07	0.965	267.28	732.72	24.70
35	300.74	658.26	0.959	313.60	686.40	28.98
40	343.77	608.23	0.952	361.10	638.90	33.37
45	386.75	557.25	0.944	409.69	590.31	37.86
50	429.65	504.35	0.934	460.01	539.99	42.51
55	472.64	451.36	0.924	511.52	488.48	47.27
60	515.60	398.40	0.914	564.11	435.89	52.13
65	558.61	343.39	0.902	619.30	380.70	57.23
70	601.55	288.45	0.890	675.90	324.10	62.46
75	644.58	232.42	0.877	734.98	265.02	67.92
80	687.57	176.43	0.864	795.80	204.20	73.54
85	730.51	119.49	0.850	859.43	140.57	79.42
90	773.53	0.47	0.834	927.49	72.51	85.71

Capacities of Common Utensils.—For ordinary measuring purposes a wineglass may be said to hold 2 ounces.

A tablespoon, ½ ounce.

A dessertspoon, ¼ ounce.

A teaspoon, ⅛ ounce, or 1 drachm.

A teacupful of sugar weighs ½ pound.

Three tablespoonfuls weigh ¼ pound.

Cook's Table.—Two teacupfuls (well heaped) of coffee and of sugar weigh 1 pound.

Two teacupfuls (level) of granulated sugar weigh 1 pound.

Two teacupfuls soft butter (well packed) weigh 1 pound.

One and one-third pints of powdered sugar weigh 1 pound.

Two tablespoonfuls of powdered sugar or flour weigh 1 pound.

Four teaspoonfuls are equal to 1 tablespoon.

Two and one-half teacupfuls (level) of the best brown sugar weigh 1 pound.

Two and three-fourths teacupfuls (level) of powdered sugar weigh 1 pound.

One tablespoonful (well heaped) of granulated or best brown sugar equals 1 ounce.

One generous pint of liquid, or 1 pint finely chopped meat, packed solidly, weighs 1 pound.

Table of Drops.—Used in estimating the amount of a flavoring extract necessary to flavor a gallon of syrup. Based on the assumption of 450 drops being equal to 1 ounce.

One drop of extract to an ounce of syrup is equal to 2 drachms to a gallon.

Two drops of extract to an ounce of syrup are equal to 4½ drachms to a gallon.

Three drops of extract to an ounce of syrup are equal to 6½ drachms to a gallon.

Four drops of extract to an ounce of syrup are equal to 1 ounce and 1 drachm to a gallon.

Five drops of extract to an ounce of syrup are equal to 1 ounce and 3⅛ drachms to a gallon.

Six drops of extract to an ounce of syrup are equal to 1 ounce and 5½ drachms to a gallon.

Seven drops of extract to an ounce of syrup are equal to 2 ounces to the gallon.

Eight drops of extract to an ounce of syrup are equal to 2 ounces and 2½ drachms to a gallon.

Nine drops of extract to an ounce of syrup are equal to 2 ounces and 4½ drachms to a gallon.

Ten drops of extract to an ounce of syrup are equal to 2 ounces and 6¾ drachms to a gallon.

Twelve drops of extract to an ounce of syrup are equal to 3 ounces and 3¼ drachms to a gallon.

Fourteen drops of extract to an ounce of syrup are equal to 4 ounces to a gallon.

Sixteen drops of extract to an ounce of syrup are equal to 4 ounces and 4⅛ drachms to a gallon.

Eighteen drops of extract to an ounce of syrup are equal to 5 ounces and 1 drachm to a gallon.

NOTE.—The estimate 450 drops to the ounce, while accurate and reliable enough in this particular relation, must not be relied upon for very exact purposes, in which, as has frequently been demonstrated, the drop varies within a very wide range, according to the nature of the liquid, its consistency, specific gravity, temperature; the size and shape of the aperture from which it is allowed to escape, etc.

Fluid Measure.—U. S. Standard, or Wine Measure.—Sixty minims are equal to 1 fluidrachm.

Eight fluidrachms are equal to 1 fluidounce.

Sixteen fluidounces are equal to 1 pint.

Two pints are equal to 1 quart.

Four quarts are equal to 1 gallon.

One pint of distilled water weighs about 1 pound.

Percentage Solutions.—To prepare the following approximately correct solutions, dissolve the amount of medicament indicated in sufficient water to make one imperial pint.

For $\frac{1}{50}$ per cent, or 1 in 5,000 solution, use $1\frac{3}{4}$ grains of the medicament.

For $\frac{1}{20}$ per cent, or 1 in 2,000 solution, use $4\frac{3}{8}$ grains of the medicament.

For $\frac{1}{10}$ per cent, or 1 in 1,000 solution, use $8\frac{3}{4}$ grains of the medicament.

For $\frac{1}{4}$ per cent, or 1 in 400 solution, use $21\frac{7}{8}$ grains of the medicament.

For $\frac{1}{2}$ per cent, or 1 in 200 solution, use $43\frac{3}{4}$ grains of the medicament.

For 1 per cent, or 1 in 100 solution, use $87\frac{1}{2}$ grains of the medicament.

For 2 per cent, or 1 in 50 solution, use 175 grains of the medicament.

For 4 per cent, or 1 in 25 solution, use 350 grains of the medicament.

For 5 per cent, or 1 in 20 solution, use $437\frac{1}{2}$ grains of the medicament.

For 10 per cent, or 1 in 10 solution, use 875 grains of the medicament.

To make smaller quantities of any solution, use less water and reduce the medicament in proportion to the amount of water employed; thus $\frac{1}{2}$ imperial pint of a 1 per cent solution will require $43\frac{3}{4}$ grains of the medicament.

Pressure Table.—This table shows the amount of commercial sulphuric acid (H_2SO_4) and sodium bicarbonate necessary to produce a given pressure:

120 Pounds Pressure.

Water, gallons	Soda Bicar., Av. ounces	Acid Sulph., Av. ounces
10	86	50
20	123	71
30	161	93
40	198	118
50	236	138

135 Pounds Pressure.

Water, gallons	Soda Bicar., Av. ounces	Acid Sulph., Av. ounces
10	96	56
20	134	73
30	171	100
40	209	122
50	246	144

If marble dust be used, reckon at the rate of 18 ounces hot water for use.

Syrup Table.—The following table shows the amount of syrup obtained from

1. The addition of pounds of sugar to 1 gallon of water; and the

2. Amount of sugar in each gallon of syrup resulting therefrom:

Pounds of sugar added to one gallon of cold water.	Quantity of syrup actually obtained.			Pounds of sugar in one gallon of syrup.
	Gallons.	Pints.	Fluid-ounces.	
1	1	—	10	.93
2	1	1	4	1.73
3	1	1	14	2.43
4	1	2	3	3.05
5	1	3	2	3.6
6	1	3	12	4.09
7	1	4	6	4.52
8	1	5	—	4.92
9	1	5	10	5.28
10	1	6	4	5.62
11	1	6	14	5.92
12	1	7	8	6.18
13	2	—	2	6.38
14	2	—	12	6.7
15	2	1	6	6.91

TABLE-TOPS, ACID-PROOF:
See Acid-Proofing.

TABLES FOR PHOTOGRAPHERS:
See Photography.

TAFFY:
See Confectionery.

TALCUM POWDER:
See Cosmetics.

TANK:

To Estimate Contents of a Circular Tank.—The capacity of a circular tank may be determined by multiplying the diameter in inches by itself and by .7854 and by the length (or depth) in inches, which gives the capacity of the tank in inches, and then dividing by 231, the number of cubic inches in a United States gallon.

TAPS, TO REMOVE BROKEN:

First clean the hole by means of a small squirt gun filled with kerosene. All broken pieces of the tap can be removed with a pair of tweezers, which should be as large as possible. Then insert the tweezers between the hole and flutes of the tap. By slowly working back and forth and occasionally blowing out with kerosene, the broken piece is easily released.

TATTOO MARKS, REMOVAL OF:

Apply a highly concentrated tannin solution on the tattooed places and treat them with the tattooing needle as the tattooer does. Next vigorously rub the places with a lunar caustic stick and allow the silver nitrate to act for some time, until the tattooed portions have turned entirely black. Then take off by dabbing. At first a silver tannate forms on the upper layers of the skin, which dyes the tattooing black; with slight symptoms of inflammation a scurf ensues which comes off after 14 to 16 days, leaving behind a reddish scar. The latter assumes the natural color of the skin after some time. The process is said to have given good results.

TEETH, TO PREVENT DECAY:

Lime water made from coarse unslaked lime, is an excellent preventive of decay—crush the lime to a powder, then take a half cupful of the powdered lime and put in a quart bottle of cold water. Shake thoroughly. Allow the undissolved lime to settle at the bottom of the bottle. This will take some little time. After it has settled, pour off as much of the clear water as can be poured without losing any of the lime. Again fill the bottle with cold water, shake well and allow the solution to clear again. After the lime has collected at the bottom of the bottle fill a twelve ounce bottle with the clear solution of lime water, being careful not to stir up the lime at the bottom. After brushing and flossing the teeth, take a little of the lime water in the mouth forcing it back and forth between the teeth until it foams. Then rinse the mouth with cold water.

TEETH, TO WHITEN DISCOLORED:

Moisten the corner of a linen handkerchief with hydrogen peroxide, and with it rub the teeth, repeating the rubbing occasionally. Use some exceedingly finely pulverized infusorial earth, or pumice ground to an impalpable powder, in connection with the hydrogen peroxide, and the job will be quicker than with the peroxide alone.

TERRA COTTA SUBSTITUTE:

A substance, under this name, designed to take the place of terra cotta and plaster of Paris in the manufacture of small ornamental objects, consists of